# PART 533 – SOIL ENGINEERING

## SUBPART A - ENGINEERING CLASSIFICATION OF SOILS

### 533.00 General

(a) Soils are used as construction materials and foundations for engineering structures. The wide range of soil properties and conditions affect their performance and use.

(b) An engineering soil classification system indicates engineering soil properties and provides a preliminary understanding of the behavior of soils under various engineering conditions. It is used to communicate this information in simple notations and brief descriptions. Soil engineers and geologists, for example, frequently communicate this information. Soil engineers perform soil testing programs, engineering designs, and soil engineering related construction activities. Geologists perform site investigations to gather information on soil properties and conditions to be used by soil engineers.

### 533.01 Scope

This policy establishes the soil classification systems that will be used in NRCS engineering activities, including the engineering sections of soil survey reports.

### 533.02 Soil classification systems

(a) The Unified Soil Classification System (USCS), is to be used in NRCS engineering activities. The Unified System is the standard accepted by the American Society for Testing and Materials (ASTM), Designation D2487: Classification of Soils for Engineering Purposes; and Designation D2488: Description and Identification of Soils (Visual-Manual Procedure).

(b) The USDA National System of Soil Classification (Soil Taxonomy) is the pedological classification used in the National

Cooperative Soil Survey. Additional information can be obtained from the National Soil Survey Handbook. The engineering sections of soil survey reports include both the USDA and the USCS soil classification systems.

(c) Soil classes determined by the Unified Soil Classification System and the USDA textural classes in the pedological system provide information on the nature and size of soil particles. If the full combination of characteristics denoted by pedological soil names is used, additional information such as natural drainage condition can also be deduced. Soil surveys show the location and extent of different soils; however, site specific identification or classification determined by soil testing is needed for designing engineering structures. Soil classification for engineering uses is best interpreted by the Unified Soil Classification System.

(d) Data contained in available soil survey reports can be used and should be supplemented as necessary to classify soils at specific sites. For some small farm-type structures, soil survey information properly interpreted may provide much of the soil information needed for planning and installation.

(e) All engineers and geologists shall be trained to use both the Unified and the USDA textural systems with competence. Construction inspectors, engineering and physical science technicians, and conservation technicians shall also be trained in these soil classification systems needed for planning, design, and installation of conservation practices.

## SUBPART B - OPERATIONS

### 533.10 General

(a) Soil mechanics is that part of physical science which deals with the action of forces on soil bodies. These actions are usually measured in testing laboratories. Soil engineering is the practice of engineering which involves the action of forces on soil masses.

(b) Collection and analysis of soil engineering data are essential in the investigation and design of engineering structures. The examination and verification of soil properties during construction are also critical. Special training and experience usually are needed because many factors depend on interpretation and judgment. Close coordination is needed between the investigation, soil testing, design, and construction functions.

(c) Soil mechanics testing provides data for evaluating soil and rock as engineering materials for planning, design, and construction. Test results identify the index, chemical, and engineering properties used in the analyses and design of foundations and earth or earth-supported structures.

### §533.11 Data collection

(a) The state conservation engineer is responsible for all site investigations and the collection of samples. The engineering staff or team that prepares the final design shall assist in planning the site investigation, sample selection, and final testing program.

(b) All data needed for analyzing soil conditions pertinent to planning, designing, and constructing engineering structures shall be obtained for each phase. Field tests and interpretation procedures in Part 531, Subpart A, are to be used to determine as many in situ soil properties as practical. If further testing is needed or verification of field conditions is in order, appropriate representative samples shall be obtained for laboratory testing.

(c) Before completion of the geologic investigation, the geologist, the engineer designated for soils mechanics leadership, and/or the project engineer shall jointly review the results of the investigation and the adequacy of sampling for testing. The data shall be examined to determine that it is adequate to be used for all stages of design and construction.

## §533.12 Testing

(a) Soil mechanics testing shall conform to established NRCS standards and procedures. The testing shall be completed at appropriate times during the investigation, design, and construction phases. To facilitate field investigations and construction operations, index and chemical tests may be performed in either local NRCS or commercial facilities. Laboratory tests for engineering properties (shear, consolidation, permeability, etc.) shall be performed in laboratories supervised by engineers with soil engineering expertise.

(b) For designs prepared through engineering services contracts, the testing may be performed as a phase of the total design contract. (See Part 505.) Soil mechanics testing facilities may also use engineering services contracts with commercial geotechnical facilities to supplement their own forces, redistribute peak workloads, and provide more efficient operation. Testing by non-NRCS facilities shall be reviewed and checked for accuracy and proper procedures by NRCS engineers with soil engineering expertise.

(c) NRCS soil mechanics testing services are provided through the National Soil Mechanics Center (NSMC) in Lincoln, Nebraska. The center has two testing laboratories available to perform the testing services: the laboratory at the center in Lincoln, Nebraska, to serve the West, Northern Plains, Midwest, and East Regions; and a satellite laboratory in Fort Worth, Texas, to serve the Southeast and South Central Regions.

(d) Both facilities have the equipment and personnel to run all tests routinely required for NRCS work. The testing laboratories assist each other by providing testing services during peak workload periods, when special testing is required, and other activities as their resources permit.

(e) NRCS laboratory testing will be accomplished on a first-come-first-served basis. Testing services may be requested by letter, fax, or electronic mail. The request shall include name and address of sender, name of site or project, financial project code, name of watershed or location, type of project and brief description, list of samples and type (disturbed or undisturbed), hazard class (for dams), testing requested, and any other pertinent information. States are not charged directly for testing services or assistance.

(f) If the NSMC is to perform engineering analyses, samples submitted shall be accompanied by geologic and engineering reports commensurate with the complexity of the structure. The reports shall be submitted to the head of the testing laboratory by the state conservation engineer, or others with delegated authority from the state conservation engineer.

(g) The engineering report shall include the preliminary design and other information required for setting up a testing program, establishing testing pressures, rates, and other details for completing soil tests. The report shall also explain the purpose for which samples were obtained, the potential use of the soil represented by the samples, and the expected use for the test results.

(h) The state conservation engineer shall maintain close contact with the testing facility on needed changes in the testing program as it progresses. On jobs requiring design assistance from other engineering staffs or teams, the state conservation engineer will keep that staff informed of any proposed changes in the testing.

(i) A report from the testing facility is to be submitted to the state conservation engineer and shall include all requested test data with a narrative giving details of the testing work, soil classifications, descriptions of soils, condition of samples, and observed test performances.

(j) Soil mechanics testing standards shall be established by the Director of the Conservation Engineering Division. Inspection of NRCS soil mechanics testing facilities that are national, regional, or multistate in scope shall be under the direction of the Director of the Conservation Engineering Division. The Director of the National Soil Mechanics Center shall direct the inspection of state soil mechanics testing facilities and other soil mechanics testing facilities under contract or agreement with NRCS.

(k) NRCS soil mechanics testing facilities that receive soil samples from areas where quarantine regulations are imposed, shall obtain the requirements from the Animal and Plant Health Inspection Service (APHIS), USDA, for receiving and disposing of soil samples. Each facility shall obtain a permit for receiving these samples. Requirements for taking and shipping samples under quarantine regulations are included in Part 531, Subpart F.

## §533.13 Soil engineering analyses

(a) Soil engineering analyses shall be made by the engineer closest to the field who has the necessary expertise and training. If possible, this work is done concurrently with other design work. One staff engineer shall be designated to provide soil engineering leadership in each state that has significant earth dam or other activity requiring soil engineering expertise. This engineer shall be trained in soil engineering principles. Engineers with specialized training and broad experience are usually required to make judgments and analyses for structures that require extensive soil engineering expertise, such as large earth dams and foundations with complex conditions. States that do not have the necessary expertise can obtain this assistance from another state within their region, a multistate design

staff, or an outside source. If this expertise is not available within their region, the state conservation engineer can make arrangements for assistance from the National Soil Mechanics Center.

(b) Each state conservation engineer shall evaluate workload and staff capabilities with regard to soil engineering expertise and develop an operational plan that defines the scope of assistance or staffing needed and the training required.

(c) If soil engineering analyses by the National Soil Mechanics Center are requested in conjunction with the soil mechanics testing, the state conservation engineer will arrange for the assistance and analyses. (See Part §533.13(a)) The engineer responsible for the analyses shall participate in the soil engineering phases of investigation, soil testing, design, and soil related problems during construction.

(d) The soils engineering analyses report shall be provided to the state conservation engineer documenting site conditions, preliminary design assumptions, engineering properties of soils used in the analyses, and other factors pertinent to the design and construction of the works of improvement. Appropriate recommendations for design features shall be included.

(e) If site investigations, sampling, testing, or soil engineering analyses are carried out by local sponsoring agencies or consultants, the state conservation engineer shall see that the work is reviewed by NRCS personnel that have the necessary expertise. States that regularly request soil engineering assistance from another state on designs completed by in-state NRCS personnel, shall also obtain that state's assistance on preparing contracts and reviewing soil engineering work completed by local sponsoring agencies or consultants.

533.14 National benefit activities

(a) The National Soil Mechanics Center provides assistance to the Conservation Engineering Division for a variety of activities of National Benefit, including the following:

(1) Training engineers and geologists in soil mechanics. This includes short-term staff position assignments.

(2) Developing or refining new or specialized testing techniques and equipment.

(3) Developing technical references in soil mechanics.

(4) Maintaining a testing data base and preparing correlations for design reference.

(5) Laboratory testing for correlation of test results.

(6) Investigating behavior and performance of soil as related to engineering use.

(b) The Director of the Conservation Engineering Division and the Director of the National Soil Mechanics Center will jointly develop annual and long-range plans of the kinds of activities that can be accomplished, as work force resources permit, and the priorities of national benefit work.

## SUBPART C - ENGINEERING INTERPRETATIONS OF SOIL SURVEYS

### 533.20 General

Soil scientists have been assigned leadership for seeing that engineering interpretations are made and for completing the engineering sections of soil survey reports and other forms or documents in connection with the National Cooperative Soil Survey. These interpretations, reports, and narrative sections shall be made by or with the assistance of technical staff personnel.

### 533.21 Scope

(a) This policy establishes the role of engineers and engineering geologists in soil survey activities.

(b) The policies, guidelines, and procedures relating to soil survey work are in GM 430-402.

### 533.22 Engineering responsibilities

(a) Engineers and geologists are to assist in soil survey engineering interpretations. They are to participate fully in decisions on the following:

(1) Whether engineering interpretations are to be made for a given use.

(2) Criteria and guides for making soil engineering interpretations for specific uses.

(3) The quality of soil engineering interpretations for published soil surveys, special reports, or special planning efforts.

(4) The method of presentation of data dealing with interpretations and narrative reports on engineering uses of soil.

(5) Training of soil scientists and engineers to make engineering interpretations.

(b) Engineers and geologists shall participate in making soil potential ratings. They shall assist in determining realistic corrective measures, costs, and continuing limitations for agricultural uses that require engineering practices. For nonagricultural uses, experts from outside NRCS shall be invited to participate in determining corrective measures, costs, and continuing limitations with final acceptance by NRCS engineers. Engineers are to determine if adequate data are being used to determine soil potential ratings. If certain soils are not normally used for the purpose being rated, the outside experts may need to complete more investigations and engineering testing to determine the types of corrective measures that are appropriate. NRCS engineers and geologists shall act as advisors to personnel responsible for providing leadership in making soil potential ratings. In this advisory capacity, they shall assist in the work, make recommendations, and point out deficiencies or incorrect procedures.

(c) National office personnel from the Conservation Engineering Division and Soil Survey Division shall work jointly to develop guidelines and criteria for soil survey work that requires engineering interpretations. All engineering interpretation work for soil surveys shall be prepared in accordance with established guidelines and criteria.

(d) The state conservation engineer is responsible for providing assistance in engineering interpretation work for soil survey activities in the State and shall work closely with the responsible soil scientist. This authority may be delegated to a staff engineer who has been assigned leadership in soil engineering, or to a geologist or field engineer, with sufficient training and experience.

(e) Engineers and geologists are expected to keep themselves informed on the development and use of engineering interpretations for soil surveys. Engineering training programs shall include appropriate instruction.